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A Feasibility Study

PRINCIPAL INVESTIGATOR: James L. Connolly, M.D.
Liron Pantanowitz, M.D.
Paul Herz, Ph.D.
Sughra Raza, M.D.
James G. Fujimoto, Ph.D.
Christian Chudoba, Ph.D.

CONTRACTING ORGANIZATION: Beth Israel Deaconess Medical Center
Boston, Massachusetts 02215

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James L. Connolly, M.D., Liron Pantanowitz, M.D., Paul Herz, Ph.D., Sughra Raza, M.D., James G. Fujimoto, Ph.D., Christian Chudoba, Ph.D.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Beth Israel Deaconess Medical Center
Boston, Massachusetts 02215

E-Mail: jconnoll@caregroup.harvard.edu

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Optical Coherence Tomography (OCT) is a new high-resolution imaging modality utilizing near-infrared light waves that can perform cross-sectional, real time, non-invasive images at or near the cellular level in tissue. Optical biopsies taken up to a depth of 2-3 mm can achieve transverse resolution as high a 10 microns. This novel imaging technology has the potential to improve breast cancer detection and diagnosis. The aim of this study was to determine the feasibility of applying OCT imaging to normal and pathologic human breast tissue.

OCT imaging failed to provide adequate differential tissue contrast to accurately characterize normal human breast tissue. Although certain architectural changes like stromal hyperplasia and fat necrosis were detected with optical biopsy, OCT imaging failed to identify (1) benign, pre-malignant and neoplastic epithelial changes as well as (2) stromal changes like granulation tissue, microcalcifications and desmoplasia. We are currently improving the OCT technology and additional specimens will be analyzed.

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REPORT

BACKGROUND: Optical Coherence Tomography (OCT) is a new high-resolution imaging modality utilizing near-infrared light waves that can perform cross-sectional, real time, non-invasive images at or near the cellular level in tissue. Optical biopsies taken up to a depth of 2-3 mm can achieve transverse resolution as high a 10 microns. This novel imaging technology has the potential to improve breast cancer detection and diagnosis. The aim of this study was to determine the feasibility of applying OCT imaging to normal and pathologic human breast tissue.

METHODS: Tissue was obtained from 20 mastectomy specimens removed for in-situ or invasive carcinoma. Ten to Twenty samples (each 1.0 x 0.5cm) were taken from benign & lesional breast tissue of each specimen and placed in 10% buffered formalin and/or phosphate buffered saline. OCT imaging was performed using a bench top, ultrahigh-resolution imaging system, operating at 800 to 1300-nm wavelengths with an axial image resolution of 1.5 to 6.5μm (corresponding to 1-2μm in tissue) and a transverse image resolution of 5 to 15μm. Image data was stored on a CD-ROM and reviewed using image-processing software. Following optical biopsy, oriented tissue samples were processed in the histology laboratory and 5μm serial sections (8-10 levels) were obtained, in the same plane that the probe had scanned, and stained with Hematoxylin & Eosin. Digital OCT images & histology sections were then compared and correlated for accuracy & depth of tissue visualization including resolution, tissue architecture, cellular morphology & the ability to distinguish normal & benign from malignant tissue.

RESULTS: OCT imaging was limited to a depth of 1.5μm. In no case (n=40) was the resolution satisfactory enough to clearly discern the normal breast microarchitecture. Adipose tissue provided the best reflectivity signal, and epithelial structures and stroma were more difficult to resolve. Stromal hyperplasia in one sample, and fat necrosis in two others, could be defined on OCT images. The correlation between histology & digital images for other benign lesions including fibrocystic change, adenosis, usual ductal hyperplasia and granulation tissue was poor. Microcalcifications identified in one case were not detected using OCT. All cases with ductal carcinoma *in situ* and invasive ductal carcinoma with desmoplasia were missed using optical biopsies.

CONCLUSIONS: OCT imaging failed to provide adequate differential tissue contrast to accurately characterize normal human breast tissue. Although certain architectural changes like stromal hyperplasia and fat necrosis were detected with optical biopsy, OCT imaging failed to identify (1) benign, pre-malignant and neoplastic epithelial changes as well as (2) stromal changes like granulation tissue, microcalcifications and desmoplasia. Until the resolution capabilities of OCT are further improved, this imaging modality has little or no value in the detection of breast cancer. Currently, the group under Dr. Fujimoto at the Massachusetts Institute of Technology is updating the OCT technology to improve the resolution. After that has been completed, we will image additional breast tissues to determine if the new technology improves the results.